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Determining Appropriate Forestry Extension Model:

Application of AHP in the Zagros Area, Iran

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Abstract

Determining an appropriate forestry extension model remains as a major challenge if sustainable forest management is a goal. This article was an attempt to show how the analytical hierarchy process can effectively be helpful in selecting appropriate model for forestry extension. The results revealed that the present situation fails to regard the ‘privatized extension’ as an appropriate model for the Zagros area in Iran. The results also showed while the beneficiaries select ‘cooperative extension system’ as the most appropriate model, it has no tangible difference with ‘public extension system’ as the

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second preferred option. Accordingly, a hybrid forestry extension model was recommended as an appropriate model.

Keywords: sustainable forest management, forestry extension, multi criteria decision making, analytical hierarchy process, decision support system.

1. Introduction

Sustainable forest management (SFM) has become the primary goal of forestry institutions worldwide (Mendoza and Prabhu, 2000). SFM is increasingly seen as an approach that should engage a wide range of bio-physical, socio-economic, and political aspects (Seely et al., 2004) in a decision making process. However, there are as yet few established models for conducting such a holistic engagement in SFM that shows an increasing need for simulation models and decision support tools (Black et al., 2000). Due to such multi-faceted aspects, SFM necessitates decision-making that recognizes and incorporates a multitude of variables; and conflicting objectives and constraints (Varma et al., 2000). In other words, there is a crucial need for decision support systems (DSSs) to launch a successful SFM which can include the use of a wide variety of modeling tools (Nute et al., 2004).

The term 'decision support system' refers to a series of techniques that integrates decision maker's own insights with computer information processing capabilities (Turban, 1993) to minimize the error of decisions (Brown de Colstoun et al., 2003). DSSs help managers to make decisions in situations where human judgment is an important contributor to the problem solving process, but where some limitations in human information processing impede decision making as well (Limin et al., 2006). The goal of a DSS is to amplify the capability of decision makers while respecting their right

to use human judgment and make the preferred choices. DSSs also involve an integration of data from a variety of sources (Rauscher, 1999). However, these systems do not automate management decisions simply by finding optimal solutions to a problem and make the final decision accordingly (Varma et al., 2000).

In developing and launching SFM, DSSs are most effective when implemented within an adaptive management cycle (Rauscher, 1999) including a well-defined set of indicators, monitoring systems, and mechanisms for feedback from researchers, industry, and stakeholder groups. According to Seely et al. (2004:284), DSS plays a critical role in this process by:

1. highlighting potential conflicts between competing management objectives,
2. providing a common, science-based framework for stakeholders to evaluate the potential consequences of specific management options,
3. conveying knowledge about the long-term dynamics of forest ecosystems, and
4. providing guidance for the monitoring process by projecting expected trends in selected indicators.

A first step to employ a DSS is to build-up a set of relevant criteria that will be applied in the process of decision making. To approach SFM, according to the FAO (Lanly, 1995), the following set of criteria should be taken into account: (1) extent of forest resources, (2) conservation of biological diversity, (3) forest health and vitality, (4) productive functions of the forest, (5) protective functions of the forest, and (6) forest-related economic and social needs. The latter is expected to be addressed by forestry extension models (FEMs). However, the models are blamed on inadequate and

inappropriate methods (Glendinning et al., 2001) to meet SFM. This raises the question on how to establish the forestry extension strategies in the most effective way. Indeed, a successful FEM is very crucial as it can adjust the destructive behavior of forestry communities who may put much pressure on forest. This is specifically the case in the Iranian forest management in which the main management activities (conservation and utilization) seem contradictory in the eyes of government as the main performer of forest management programs. It is therefore imperative to determine and launch an appropriate FEM in the country where one of the main forest resources stands in the Zagros area. Accordingly, the following hypotheses are assumed for this study:

- There are significant differences between the ranking of the FEMs in the Zagros area;
- ‘Cooperative extension system’ is identified as the most appropriate FEM in the view of the beneficiaries; and
- A hybrid forestry extension model is the most appropriate FEM for the area.

In this paper, first, we will explain the evolution of forestry extension models. Afterward, we will discuss different multi-criteria decision making approaches and techniques, and the need for AHP technique in this study. Further, in the methodology, we will describe the study site and the technique. Later, we will present the results of this study followed by the discussion and conclusion.

2. Forestry extension models

Throughout the world, there are many different forestry extension models for conducting the ‘extension’ job (Johnson et al., 2007) and many governments have

introduced different forestry extension programs accordingly (Low et al., 2010). Although the idea of forestry extension as a means of communicating ideas on forest management has been noticed for a long time (FAO, 1993), the practice of extension to improve the management of private and community woodlands is still on the increase worldwide (Johnson et al., 2007).

A number of different terms have been used to describe the basic activities of agricultural and forestry extension (Azadi and Filson, 2009). Yet, the need for an effective extension model has often been expressed (Malla, 1987). The FEMs have developed in response to the need for more effective means of dissemination of forestry technologies and innovations among rural communities. Sim and Hilmi (1987) define the term 'forestry extension' as being applied to any situation in which local people are willingly involved in forestry activities from which they will derive some recognizable benefits within a reasonable period of time. Anderson and Farrington (1996) describe FEMs as systematic processes of the exchange of ideas, knowledge and techniques that lead to mutual changes in attitudes, practices, knowledge, values and behavior aimed at improved forest and tree management.

Changes in FEMs are already coming from the recognition of extension failures in general, and in forestry in particular. In the past, FEMs were mostly focusing on solving technical problems, such as providing nursery skills, introducing new tree species, or technology such as improved stoves. However, despite technological advances, forestry extension has experienced uneven success in many parts of the world due to inadequate adoption rates or abandonment of the technologies (Subhrendu et al., 2003). A contributing reason may be the manner in which silvicultural technologies have been applied. Nevertheless, until recently, forestry adoption studies have been concerned

about biophysical rather than socio-economic variables (Mercer, 2004; Baynes and Herbohn, 2011). Furthermore, the evolving community-based and community driven extension practices, which are rather new, has brought up more emphasis on achieving consensus and joint actions by local people to solve the problems facing all the members, rather than on dealing with a few selected individuals (Kaudia et al., 2003).

Given the outward magnitude and nature of the changes and not always successful performance of forestry extension, Anderson and Farrington (1996) ask whether public² extension can still be useful. Many countries, particularly those with the state control on forest resources, have traditionally challenged to assure sound forest land and tree management through the application of government rules and regulations. Indeed, it is necessary to elaborate a comprehensive extension strategy involving all relevant stakeholders.

According to Braeutigam (2003), extension services should be demand-driven provided by governmental authorities in close cooperation and complementation with non-governmental organizations (NGOs). As a response to this challenge, NGOs have currently been involved in forestry extension programs. The private sector, through consulting foresters, has also played a significant role, especially where forestry is "commercial" or "industrial" and local professional associations are common. At the local level, in many countries including Iran, NGOs have also played an important role in providing people with advice on local forestry matters. Also, universities and research organizations have sometimes been directly involved in providing extension advice and personnel, alone or in cooperation with national and local governments.

² 'Public' extension is also called 'conventional' or 'governmental' extension (Axinn, 1988).

Besides, considering the interactions between agricultural and forestry activities at the local level, it is recommended that FEMs should establish close linkages and intensive cooperation with the agricultural extension systems at the regional and national levels. Like in most African countries (Temu and Kowero, 2001; Schreckenberg et al., 2006), forestry activities in Iran is under the supervision of the ministry of agriculture. Such an administrative configuration integrates forestry components into existing agricultural extension programs. The formation of the joint extension teams at the regional level would lead to more efficient, synergic agro-forestry extension approaches while each department would maintain control over their own staff. Also, given the limited human and financial resources, especially at the regional level, the development of single forestry extension service might create other problems, mainly, it will further lead to the separation from other sectors and might not reflect common decentralization efforts and realities at the community level (Braeutigam, 2003).

Such a growing emphasis has been placed on forestry extension policies and programs supported by policy makers at the national level. In addition, the policy makers have increasingly appreciated the role and stake of local people in protecting and managing forests, provided that they participate in and benefit from SFM. Accordingly, the relevant policies and legislatives to SFM are appearing more on their agenda. Despite different techniques, the general and more common applied forestry extension approach is community-based meaning that the policies and legislatives should further be developed in a consultative way, involving multi-stakeholder (Azadi et al., 2011) from the national down to the local level or as Chambers (1997) emphasizes from the local to national level. Indeed, expanding the interest and commitment of forestry extension to local people requires a dynamic process of involvement of a variety of stakeholders

from policy makers to local people in a way that can elaborate and address not only the general goals of SFM at the regional and national levels but also reflect the socio-economic and biophysical conditions of local people.

All in all, the FEMs continue to evolve. Multiple players are joining in. Most importantly, it is emerging that building capacity and capability of beneficiary communities and partners can be a viable option for entrenching the sustainable extension service provision as a ‘best practice’. This is particularly useful in developing countries which extension service delivery has deteriorated to a non-existence job (Kaudia et al., 2003). Consequently, hybrid extension models, which promote partnership of public, cooperative, and private extension services are considered as a better choice that can be applied through different forestry programs to approach SFM (Fungo and Nantongo, 2011).

3. Multi criteria decision making

Multi criteria decision making (MCDM) is a well-known branch of a general class of operations research models which deal with decision problems under the presence of a number of decision criteria (Malczewski, 1999; Petrovic-Lazarevic and Abraham 2003). The MCDM approaches range from simple technical issues to complicated socio-economic problems (Lu et al., 2007). The approaches provide a set of systematic procedures for analyzing complex decision problems like SFM. These procedures include dividing the decision problems into smaller and more understandable elements; analyzing each element and integrating them into a logical manner in order to create a meaningful solution (Grünig and Kühn 2005). By quantifying, weighting, and

evaluating each criterion and rank all alternatives, the approaches help decision makers to make their best choice (Azadi et al., 2009).

The process of MCDM is often confused by decision makers, because there are always some sort of trade-offs between criteria. The following sections provide a short overview on the approaches and techniques.

3.1. MCDM approaches

Two basic approaches to MCDM problems have been distinguished: multiple-attribute decision making (MADM) and multiple-objective decision making (MODM) (Climaco, 1997; Pohekar and Ramachandran 2004). The distinction between MADM and MODM is concerned to the evaluation criteria which are the standards of judgments (or rules) on which the alternatives are ranked according to their desirability for target groups (Lu et al., 2007). MADM problems require that choice(s) should be made among alternatives described by their attributes. It is therefore, a useful approach to choose the best among different alternatives. The set of attributes is given explicitly and multi-attribute problems have a finite set of feasible alternatives.

Unlike MADM, MODM problems explicitly deal with the relationship between different attributes of the alternatives in order to maximize/minimize a set of objectives. MODM involves designing the alternatives and searching for the best decisions among an infinite or very large set of feasible alternatives. Each alternative is defined implicitly in terms of the decision variables and evaluated by means of objective functions (Malczewski, 1997).

Finally, the main difference between MADM and MODM models can be explained by the MODM's focus on decision problems with 'continuous' decision space compared

with the MADM's focus on problems with 'discrete' nature (e.g. here in this study, selecting appropriate FEM has a discrete nature). Furthermore, the MODM models generally deal with resources attribution whereas the MADM models often deals with evaluating several predefined choices ended to the best at last (Azadi et al., 2009).

3.2. MCDM techniques

There are several techniques in each of the two approaches. Priority-based, outranking, distance-based and mixed methods which are all applied to various problems. Each technique has its own characteristics and can be classified as deterministic, stochastic and fuzzy (Pohekar and Ramachandran, 2004). There may also be a combination of the above techniques (Azadi et al., 2009). Depending upon the number of decision makers, the methods can be classified as single or group decision making (Gal and Hanne, 1999). MCDM techniques can be used to identify a single most preferred option; to list a limited number of options for subsequent detailed evaluation; to distinguish acceptable from unacceptable possibilities; or to rank options. The latter is especially workable when a decision should be made among different options through ranking methods from which AHP is used in this study to select the most appropriate FEM.

3.3. Why using AHP?

As one of the MADM techniques, AHP appears as a comprehensive technique which aims to remove, to a great extent, the problems associated with traditional methodologies (Mendoza and Prabhu, 2000; Kangas and Kangas, 2005). Initially introduced by Thomas L. Saaty in 1980, AHP is now widely used for both linear and non-linear planning processes. This technique not only allows problem formulation on a

hierarchical basis, but also provides the chance to take into consideration various qualitative and quantitative criteria for the problem. In addition, it involves different options in decision making process and allows for sensitivity analysis of both criteria and sub-criteria. Furthermore, it is based on paired comparison system, which facilitates judgments and calculations, and finally, as an outstanding advantage, it can show the decision's level of adaptability\non-adaptability (compatibility\incompatibility).

Saaty (1990) explains that by simplifying and accelerating decision-making process, AHP serves to make effective decisions when complicated problems should be dealt with. As a systematic methodology, AHP can disintegrate the component parts of an intricate unstructured problem into well-defined parts; so that one can easily understand that which variable has mostly influenced the outcomes of a situation. According to him, AHP enables us to understand how a system and its surrounding environment are formed as interactive components. It then determines, through a mixture of measurement and classification, how much each component influences the whole system. This process organizes feelings, emotions and logics into a well-defined structure to be used for decision-making.

In a general categorization, Saaty (1986) has divided hierarchy into two categories: structural and functional. In the former, the components/elements are generally linked physically. It means that complicated systems are founded on a group of major components according to specific structural-theoretical characteristics of size, shape, color, or age. In the latter, in contrast, the components are task-related to form a system. Functional hierarchy, thus helps people direct a system toward a further productivity and a better implementation (in this research, accordingly, functional hierarchy has been employed).

Drake (1998) states that AHP involves paired comparisons. As a first step, decision maker delineates the decision's overall hierarchy and then proceeds to identify various factors and alternatives that need to be involved in the decision. Later, the paired comparisons determine coefficient of factors and finally result in the factors assessment. Both Saaty (1980) and Drake (1998) consider five major stages for performing AHP: 1) creating hierarchical tree, 2) pairwise comparing of research criteria and options, 3) operations for computing data, 4) sensitivity analysis, and 5) the level of non-adaptability (incompatibility).

4. Methodology

4.1. Study site and sample

The Zagros area is considered as the main site for this study. The area spans the whole length of the western and south-western of the Iranian plateau and ends at the Straits of Hormuz. Classified as a semi-arid forest region with an area of 5 million ha, the Zagros area includes 40% of the national forests. It also covers 12 provinces (Azerbaijan Gharbi, Kurdistan, Kermanshah, Eilam, Lorestan, Chaharmahal-Bakhtiari, Fars, Isfahan, Khuzestan, Kohgiluyeh-Boyerahmad, Hamedan, and Markazi) and covers over 1300 km (Fig. 1).

[Insert Fig. 1 here]

According to the Iranian Statistics Centre (2006), the area holds 83 townships and more than 19200 villages that cover some 25% of the total national area and nearly 30% of the total population. More than 70% of the Iranian nomads live in this area where

includes around 50% of the total livestock population; i.e. approximately 63,142,000 heads. At the national level, the area is appreciated as the first producer of wheat and forage in the country. In addition, it plays a significant role in the national economy because of the abundance of oil fields, minerals, water resources, production of herbal medicines, associated with aquaculture, apiculture, and ecotourism.

Given the specific features of the AHP technique, people with tertiary educational levels have been selected from among the beneficiaries in the selected provinces by using a purposive sampling method (Patton, 2002). Accordingly, 9, 26, and 15 individuals were selected respectively from Kurdistan, Ilam, and Fars provinces. Group AHP technique has been used for identifying the appropriate forestry extension model for the Zagros area.

4.2. AHP technique

As required by the specific nature of this research, a particular model of decision tree has been employed for designing and determining the most appropriate FEM for the Zagros area. The tree's branches are, indeed, occasional events or uncontrolled variables that each can be divided into other branches for decision-making. Finally, every branch, would lead to a given result, which in reality, by itself, realizes to some specific degree of the decision's objective. AHP has therefore been used to achieve the intended objective. Also, as an MADM approach, it has been employed for selecting one alternative from among the intended alternatives, and determining their "importance", "likelihood", and "priority" or preference. It means that by using this technique, we can well select and introduce, from among the existing forestry extension models, one that best fits the conditions and peculiarities of the Zagros area. This process consists of

three parts: paired comparisons; combination, and sensitivity analysis. The same pattern has been followed for selecting the most appropriate forestry extension system for this study. Fig. 2 shows hierarchical (decision) tree and the related criteria, sub-criteria, and options used for selecting an appropriate FEM.

[Insert Fig. 2 here]

5. Results

Our hierarchical tree in this study consists of four levels:

Objective: Determining an appropriate forestry extension model.

Criteria:

- C1. Belief in popular (beneficiaries) participation in forestry activities;
- C2. Ability in recruiting extension agents;
- C3. Making use of diffusion technology;
- C4. Ability in developing and implementing extension programs;
- C5. Managing and organizing.

Sub-criteria:

- SC1. Beneficiaries' participation in planning process;
- SC2. Beneficiaries' participation in implementation process;
- SC3. Ability in recruiting local extension agents;
- SC4. Ability in recruiting specialized extension agents;
- SC5. Making use of research findings;
- SC6. Using diversified training methods;

- SC7. Ability in developing extension programs;
- SC8. Ability in implementing extension programs;
- SC9. Belief in decentralized extension management;
- SC10. Belief in the role of local leaders in managing forests.

Options:

- O1. Public extension model;
- O2. Cooperative extension model;
- O3. Privatized extension model.

A matrix-wise comparison of the criteria is presented in Table 1.

[Insert Table 1 here]

Findings of the paired comparisons show that the criterion "belief in popular participation in forestry activities" has less importance than other criteria involved. In contrast, the criterion "recruiting extension agents" has greater importance than other criteria, namely "belief in popular participation in forestry activities", "making use of diffusion technology" and "managing and organizing". Meanwhile, this criterion is equal to "developing and implementing extension programs" in terms of priority level. Also, "making use of diffusion technology" and "managing & organizing" stand at the same level of importance.

Table 2 shows the weight (value) for each item obtained from the paired comparisons of criteria, sub-criteria and the related options.

[Insert Table 2 here]

As shown in the table, priority weights (value) assigned to two criteria, i.e. “ability in recruiting extension agents” and “ability in developing and implementing extension programs” are greater than the weights of other items. It also indicates that sub-criteria “participation in planning”, “recruiting local extension agents”, “using diversified training methods”, “ability in developing extension program”, and “belief in decentralized extension management” have, respectively, greater importance than “participation in implementation”, “recruiting specialized extension agents”, “making use of research findings”, “ability in implementing extension programs”, and “belief in the role of local leaders in management”. As far as appropriate option for each sub-criterion is concerned, “privatized extension” option has been, by no means, selected as an appropriate model. Whereas the other two options (i.e. “cooperative extension”, and “public extension”) have been each recognized as appropriate model with respect to the five sub-criteria.

A combination of results reveals that the weights for the three above-mentioned models are as follows:

1. Cooperative extension model = 39.8% (first option)
2. Public extension model = 34.6% (second option)
3. Privatized extension model = 25.5% (third option)

Fig. 3 indicates to what extent the options are sensitive to a change in criteria priorities. As shown, “cooperative extension model”, compared to the two other options, is recognized as “the most appropriate”.

[Insert Fig. 3 here]

6. Discussion and conclusion

Sustainability of forests in the Zagros area depends, to a large extent, on both adherence to proven forestry practices and participation by forest dwellers (beneficiaries). In order to preserve, restore, and develop the forests, a variety of forest resources management project plans have been designed and carried out in the area since 1996. Followed naturally by the establishment of the related cooperatives, these activities have come to introduce community forestry as an efficient approach to forest management. Focusing on the community forestry in the Zagros area calls for several mechanisms that need to be taken into consideration: beneficiary-centered attitude, public supports, adequate research efforts, systematic participation, legal requirements, an integrated extension network, etc. Also, mechanisms such as utilizing local resources, using local leaders for community management, allocating adequate financial resources and credits as low-rate loans, and the like, need to be delivered with greater attention if an optimized management for forestry extension is a goal.

In general, this paper showed that AHP is an effective technique for selecting an appropriate FEM. The technique provides policy makers with a quantitative decision support tool in order to determine the most appropriate forestry extension service by an efficient combination of inputs and outputs that can best fulfill the objectives of the SRM. In particular, the technique reveals that present situation fails to regard privatized extension model as an appropriate one for the Zagros area. Beneficiaries have selected cooperative extension system as the most appropriate one. However, it has no tangible difference with public extension system as the second preferred option. The pairwise comparison approach used in AHP improves the beneficiaries' insight since such

comparisons force them to think about the weights of the factors and to analyze the different FEMs according to the objectives of the SRM.

Nonetheless, one could argue that the design of the technique (including the database contents) is deterministic. That AHP, like other deterministic techniques, is unable to reflect the inherent randomness of biophysical and socio-economic conditions, and their effects on SFM. However, there is no a priori exclusion of options which might interfere with the interests of the local forest authority. It might also be acknowledged that a drawback (because of some silvicultural decision problems such as decisions on biodiversity issues information at spatial scales) is needed. As a consequence, indicators for the forest conservation objectives might necessarily be restricted to relatively simple parameters.

In sum, AHP provides a computer-based framework for integrating data and expert opinion with analytical and operational research models, by means of graphic display and tabular reports, to reveal the basis of support for alternative decisions on SFM. It enables policy-makers to access information in a structured inclusive decision on a complex situation like SRM, which can otherwise be exclusive. Moreover, through the use of AHP, the process of decision making is automatically documented and thus transparent decision on SFM can be made.

As suggested by the criteria for selecting an appropriate FEM, the Iranian government, as the main controller and provider of credit needs, and cooperatives, as implementing agents, can together contribute to further realization of community forestry extension objectives in the Zagros area. While forestry extension in Iran was previously meant not more than providing trees for the public at subsidized prices, the results of this study showed that the forestry extension programs should go beyond the public model and

implement cooperative and private approaches as well. Such approaches can promote the participation of local people and introduce skills and techniques both to conserve and utilize the Zagros forests in a more sustainable manner. However, in order to better cater the various target groups of the beneficiaries, due to the results, it seems to be a better option to implement a hybrid FEM which could mostly be “public and cooperative”, and partially private. Therefore, a hybrid model (partly centralized and partly decentralization) might be optimum. Developing such a hybrid model can be suggested as the implications of this research for future studies. The studies can further tell us the contribution of the different models in the hybrid model taking a series of case studies on the bases of both ‘forestry activity-case’ and ‘regional-case’.

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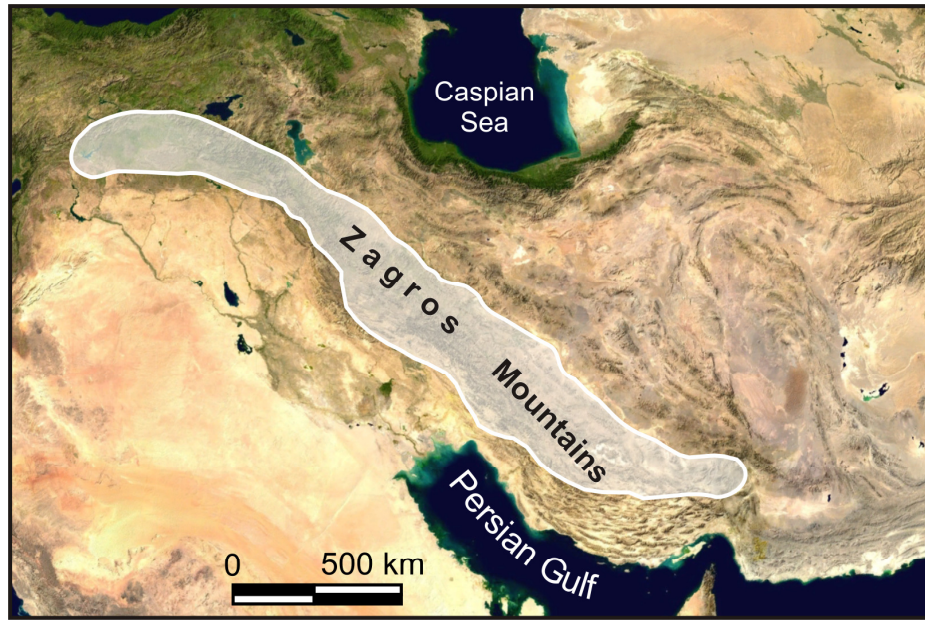


Fig. 1. The Zagros fold belt.

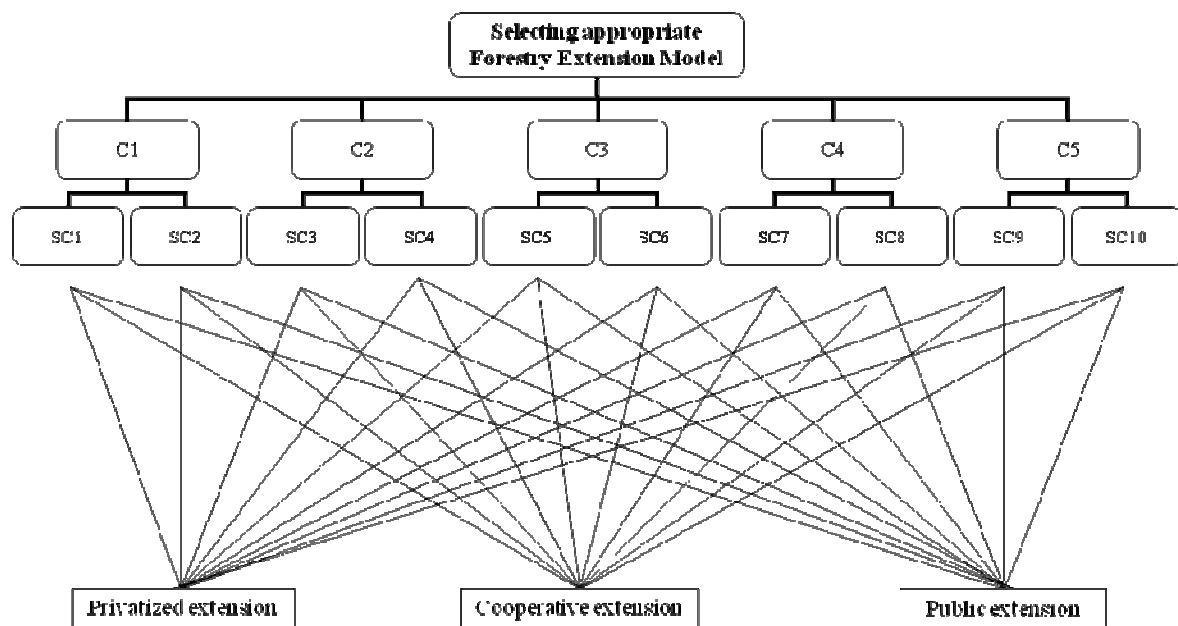


Fig. 2. Hierarchical (decision) tree for selecting an appropriate forestry extension model

C1. Belief in popular (beneficiaries) participation in forestry activities;

C2. Ability in recruiting extension agents;

C3. Making use of diffusion technology;

C4. Ability in developing and implementing extension programs;

C5. Managing and organizing.

SC1. Beneficiaries' participation in planning process;

SC2. Beneficiaries' participation in implementation process;

SC3. Ability in recruiting local extension agents;

SC4. Ability in recruiting specialized extension agents;

SC5. Making use of research findings;

SC6. Using diversified training methods;

SC7. Ability in developing extension programs;

SC8. Ability in implementing extension programs;

SC9. Belief in decentralized extension management;

SC10. Belief in the role of local leaders in managing forests.

Table 1. comparison of the criteria through AHP.

Criteria	Recruiting extension agents	Technology	Program	Management
Participation	1.7*	1.6*	1.7*	1.7*
Recruiting extension agents		1.3*	1.0	1.2
Technology			1.2*	1.0
Program				1.2

* Stars show "priority" and "reversed importance" of the criteria.

Table 2. Comparison of criteria, sub-criteria, the related options, and the calculated weights

Criteria	Calculated weights	Sub criteria	Calculated weights	Calculated weights of options		
				Public extension	Cooperative extension	Privatized extension
Belief in popular participation	0.131	Participation in planning	0.543	0.427	0.386	0.188
		Participation in implementation	0.457	0.201	0.625	0.174
Ability in recruiting extension agents	0.238	Recruiting local extension agents	0.785	0.199	0.535	0.265
		Recruiting specialized extension agents	0.242	0.653	0.182	0.165
Making use of diffusion technology	0.196	Making use of research findings	0.457	0.469	0.261	0.270
		Using diversified training methods	0.543	0.400	0.294	0.306
Ability in developing & implementing extension programs	0.233	Ability in developing extension programs	0.673	0.466	0.299	0.233
		Ability in implementing extension programs	0.327	0.233	0.598	0.169
Managing & organizing	0.203	Belief in decentralized extension management	0.543	0.256	0.425	0.381
		Belief in local leaders in management	0.457	0.265	0.439	0.297

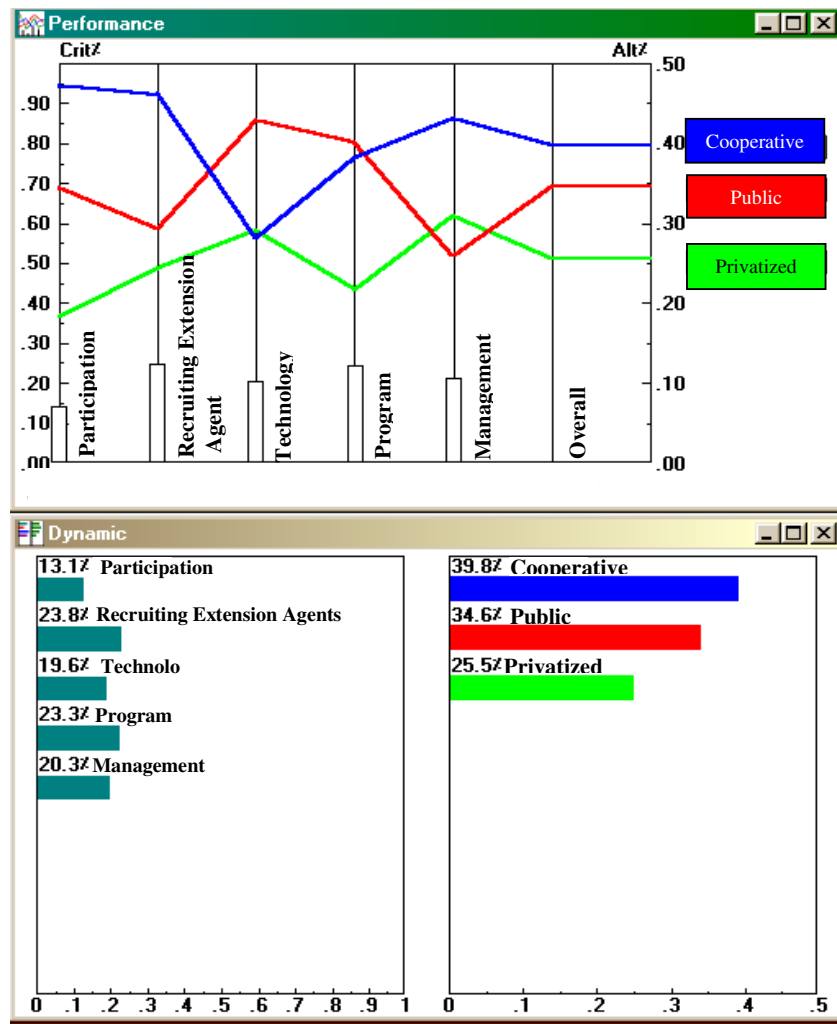


Fig. 3. Sensitivity analysis for selecting an appropriate forestry extension model.